REMARKS

Upon entry of the instant amendment, claims 1, 4-5, 7, 10-11, 13-14 and 17-24 will remain pending in the present application.

In the instant amendment, claims 3, 9 and 15-16 have been canceled without prejudice or disclaimer of the subject matter contained therein. Claims 1, 5, 7, 10 and 11 have been amended. Also, new claims 21-24 have been added.

The instant amendment made herein to the claims does not incorporate new matter into the application as originally filed. For example, the amendment to claim 1 is based on claim 3 and the disclosure at page 4, lines 32-36 of the instant specification. The amendment to claim 7 is based on claim 9 and the disclosure at page 10, lines 12-14 of the instant specification. The amendment to claim 10 is based on the disclosure at page 10, lines 12-14 of the instant specification. New claims 21 and 23 are based on claim 5, respectively. New claims 22 and 24 are based on the disclosure at page 11, lines 26-29 of the instant specification, respectively.

Accordingly, proper consideration of each of the pending claims is respectfully requested at present, as is entry of the present amendment.

35 U.S.C. § 112, Second Paragraph Rejection

At pages 2-3 of the Office Action, the Examiner has rejected claims 5 and 11 under 35 U.S.C. § 112, second paragraph, as being indefinite in the outstanding Office Action. Applicants respectfully traverse and request that the Examiner withdraw the rejection based on the following explanations.

In claims 5 and 11, the phrase "*the metal oxide layer and/or metal nitride layer has a thickness of at least 0.1 μm but not more than 100 μm*" has been deleted respectively to overcome the rejection. Further, new claims 21 and 23 have been added to recite such a feature.

Thus, Applicants respectfully request that the Examiner withdraw the rejection.

Rejection of Claims 7, 9-11, 15-16, 19 and 20 under 35 U.S.C §§ 102 and 103

At paragraph *"6."* at pages 3-4 of the Office Action, claims 7, 9-11, 15-16, 19 and 20 have been rejected under 35 U.S.C. § 102(b) as being anticipated by Nishiuchi U.S. '590 (U.S. Published Application No. 2001/0030590).

Further, at paragraph "*9.*" at pages 5-6 of the Office Action, claims 10-11, 16 and 20 have been rejected under 35 U.S.C. § 102(b) as being anticipated by or under 35 U.S.C. § 103(a) as being unpatentable over Nishiuchi U.S. '196 (U.S. Patent No. 6,251,196).

Applicants respectfully traverse and request that the Examiner withdraw the rejection based on the following explanations.

The Present Invention and Its Advantages

Independent claim 7 is directed to a method of manufacturing rare-earth sintered magnets. In the claimed method, a step of metal plating is conducted so as to form a multilayer comprising a copper bottom layer followed by a nickel layer, and further the oxide or nitride layer is formed on the surface of the plated metal (i.e., the nickel surface). Through the claimed method, hydrogen embrittlement of the magnet is inhibited and the magnet exhibits excellent hydrogen resistance.

Independent claim 10 is directed to a rare-earth sintered magnet. Similarly, the claimed rare-earth sintered magnet has a multilayer having a copper bottom layer followed by one or more nickel layer. With the multilayer, hydrogen embrittlement of the magnet is inhibited and then the magnet exhibits excellent hydrogen resistance.

In short, in the method of claim 7 and the rare-earth sintered magnet of claim 10, by employing such a metal plating step (claim 7) or such a multilayer (claim 10), hydrogen embrittlement of the magnet is effectively inhibited and then the magnet exhibits excellent hydrogen resistance.

The declaration under 37 C.F.R. § 1.132 signed by a co-inventor, Mr. Kazuaki Sakaki is attached hereto in order to show the significance of the features of the present invention. It is evident from the declaration that such features of the present invention are technically significant since when the copper bottom layer is not formed, hydrogen embrittlement occurs at the hydrogen gas test even if one or more nickel layers are formed and further the oxide or nitride layer are formed thereon.

For example, as shown in the data of the declaration (see, for example, Table I of the declaration), the desired hydrogen resistance as intended by the invention could not be attained in following samples: the sample where only an epoxy resin coating was employed (Comparative Example 7); the sample where an epoxy resin coating was formed after formation of a Cu-Ni plating layer without forming an oxide layer (Comparative Example 8); the sample where an oxide layer was formed after formation of a Cu-Ni plating layer but was very thin due to a low heat treatment temperature (Comparative Example 11); and the sample where a Cu undercoat

was not formed, only a Ni plating layer was formed and heat treated under the conditions as prescribed by the invention (Comparative Example 12).

Further, in Comparative Examples 11 and 12, the magnetic properties (iHc and $(BH)_{max}$) were degraded by post-plating heat treatment. Their magnetic properties were not measurable after hydrogen gas treatment because the magnets were disintegrated by hydrogen gas treatment. In Comparative Example 10, a Cu-Ni plating layer was formed and heat treated at a temperature above the heat treatment temperature range of the invention so as to form a thicker oxide layer, thus obtained sample exhibited hydrogen resistance, but its magnetic properties was substantially degraded, especially iHc and $(BH)_{max}$, after the heat treatment.

In contrast, according to the present invention, by employing the steps of metal plating and subsequent heat treatment (claim 7) or the multilayer (claim 10), it is assured to manufacture rare earth sintered magnets which have excellent hydrogen resistance and minimal deterioration of magnetic properties caused by a heat treatment. Notably, all the samples of Examples had an epoxy resin coating formed thereon. The result of Comparative Example 1 and a comparison between Comparative Examples 11 and 12 reveal that formation of an epoxy resin coating does not contribute to hydrogen resistance. When the inventors made the present invention, they had already confirmed that as described in Examples 1 and 2, the hydrogen resistance did not depend on whether an epoxy resin coating was formed.

The reason why hydrogen resistance is achieved by the present invention is not exactly understood. At the present, Applicants explains the reason below. However, it is noted that such a mechanism accounting for hydrogen resistance as described herein is to illustrate significance of the present invention, not to limit the scope of the claims.

Hydrogen embrittlement occurs because hydrogen atoms, which are the smallest among all the elements, can penetrate into and migrate throughout crystal lattices of metal even at normal temperature. In this regard, it is important that hydrogen is in the atomic form rather than the molecular form. On the metal surface, hydrogen molecules are unbound into atoms under the catalysis of that metal. Such atoms penetrate into crystal lattices of the metal causes hydrogen embrittlement. A well-known example is hydrogen embrittlement of carbon steel. As hydrogen penetrates into steel, the steel is decarburized and the properties thereof substantially impaired not only in mechanical strength but also in ductility and toughness, leading to eventual fissure. In the case of rare earth magnets, such a phenomenon occurs more outstandingly. This is because a rare earth element (main constituent element of rare earth magnet) has a larger atom radius than a transition metal element (main constituent element of steel) and because the intermetallic distance in crystals in an intermetallic compound is greater in the case of rare earth magnets. In addition, since a rare earth element is prone to form a compound with hydrogen, the hydrogen having penetrated into a rare earth magnet binds with a rare earth element to form a rare earth hydride which causes volume expansion, incurring a plurality of fissures and eventual powdering.

For improving hydrogen resistance, it is the most important to prevent hydrogen molecules from being unbound to atoms. It is believed that an oxide layer has a lower activity than a metal layer and hence catalytic action to unbind hydrogen molecules to atoms is little. Also, when a simple comparison was made between Cu and Ni platings, which are routine plating surface treatments on rare earth magnets, it was empirically found that the Cu plating is superior in hydrogen resistance. This probably depends on the strength of catalytic action to

unbind hydrogen molecules to atoms on the metal surface. Namely, Ni has a more likelihood to unbind hydrogen molecules into atoms than Cu. (This likelihood is easily presumed from the fact that Ni is used as the main element of hydrogen storage alloys or La-Ni alloys.) While it is possible to form an oxide layer on Cu plating surface, this oxide layer is susceptible to delamination and difficult to retain, and thus it makes it difficult to provide satisfactory hydrogen resistance. By contrast, the Ni plating is free from such a problem.

The present invention achieves satisfactory hydrogen resistance by providing a Nd-base rare earth sintered magnet with Cu plating, subsequent Ni plating and an oxide layer thereof. First, the oxide layer on the outermost surface prevents hydrogen molecules from being unbound to atoms. Secondly, even if the Ni plating layer has some defects, the Cu plating layer capable of preventing hydrogen molecules from being unbound to atoms lies underneath the Ni plating layer so that the Cu plating layer makes up for the defects in the Ni plating layer, ensuring prevention of hydrogen embrittlement.

Distinctions over the Cited References and Combination Thereof

Nishiuchi U.S. '590 and Nishiuchi U.S. '196 fail to disclose or suggest the subject matter of the currently amended claims 7 and 10, especially forming a multilayer comprising copper bottom layer followed by nickel layer and an oxide or nitride layer on the multilayer.

Thus, the present invention is distinguishable from the cited references. Further, a *prima facie* case of obviousness is not established based on the cited references since none of the cited references disclose or suggest such features of the present invention. Likewise, it follows that a

person having ordinary skill in the art would not be motivated by any of the teachings of the cited references and by the general knowledge to arrive at the present invention.

Accordingly, the present invention (independent claims 7 and 10 and dependent claims thereof) is not obvious over the cited references. Applicants respectfully request that the Examiner withdraw the rejections.

Rejection of Claims 1, 3, 13 and 17 under 35 U.S.C § 103

At paragraph "*11.*" at pages 6-7 of the Office Action, claims 1, 3, 13 and 17 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Anderson U.S. '303 (U.S. Patent No. 5,382,303) in view of Shinichi JP '016 (Japanese Patent Document No. 08-181016).

Applicants respectfully traverse and request that the Examiner withdraw the rejection based on the following explanations.

Distinctions over the Cited References and Combination Thereof

As recited in claim 1, the present invention is directed to a method having a metal plating step and then a heat treatment step in an atmosphere having an oxygen partial pressure of 10^{-4} Pa to 50 kPa so as to form an oxide layer of the metal-plating metal as a hydrogen resistance layer. Thus obtained magnets have excellent hydrogen resistance.

First, Anderson U.S. '303 fails to disclose or suggest the inventive surface treatment.

Next, Shinichi JP '016 discloses a method of manufacturing samarium cobalt magnet comprising forming a nickel film having a thickness of 10 to 50 μm on the surface of sintered

samarium cobalt magnet, heat treating the magnet at 700 to 900°C for 1 to 4 hours in an atmosphere of an inert gas, and then cooling the magnet.

However, in Shinichi JP '016, the heat treatment is not conducted in the presence of oxygen to form a nickel oxide layer. Thus, the resulting magnet of Shinichi JP '016 does not have sufficient hydrogen resistance. Further, the object of the method of Shinichi JP '016 is to improve mechanical strength while preventing crack occurrence. Accordingly, Shinichi JP '016 is silent about the hydrogen resistance or the inhibition of hydrogen embrittlement.

Therefore, Shinichi JP '016 does not provide any suggestion for one skilled in the art to arrive at the present invention, which has excellent hydrogen resistance.

Further, a *prima facie* case of obviousness is not established based on the cited references since the cited references fail to disclose or suggest such features of the present invention. Likewise, it follows that a person having ordinary skill in the art would not be motivated by any of the teachings of the cited references and by the general knowledge to arrive at the present invention.

Accordingly, the present invention (independent claim 1 and dependent claims) is not obvious over the cited references. Applicants respectfully request that the Examiner withdraw the rejection.

Allowable Subject Matter

At paragraph "*12.*" at pages 6-7 of the Office Action, claims 4, 5, 14 and 18 are allowed. It is noted that new claim 22 is also allowable since it depends on claim 5.

CONCLUSION

Based upon the amendments and remarks presented herein, the Examiner is respectfully requested to issue a Notice of Allowance clearly indicating that each of the pending claims are allowed under the provisions.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Toyohiko Konno (Reg. No. L0053) at the telephone number below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. §§ 1.16 or 1.17; particularly, extension of time fees.

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Respectfully submitted,

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Attachment: Declaration under 37 CFR § 1.132 of Mr. Kazuaki Sakaki

GMM/TK/kml